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GRENADES, HAND OR WEAPON LAUNCHED

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Army Test and Evaluation Command
Aberdeen Proving Ground, Maryland

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13. ABSTRACT Describes a method for evaluation of grenade operational and functional performance characteristics. Identifies supporting tests, facilities, and equipment required. Provides procedures for preoperational inspection, physical characteristics, safety personnel training, and functional suitability. Applicable to high explosive, antitank (heat), fragmentation, offensive, white phosphorous, incendiary, riot control, practice, and inert hand or weapon launched grenades. <u>Not Applicable</u> to smoke and pyrotechnic grenades.			

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U. S. ARMY TEST AND EVALUATION COMMAND
EXPANDED SERVICE TEST - SYSTEM TEST OPERATIONS PROCEDURES

AMSTE-RP-702-103

*Test Operations Procedure 4-3-030

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GRENADE, HAND OR WEAPON LAUNCHED

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SECTION I
GENERAL

1. Purpose and Scope.

a. This document provides procedures for conducting an expanded service test of hand grenades and weapon launched grenades. It establishes test methods and techniques to determine if the test grenades meet the criteria prescribed in applicable requirements documents and are suitable for use by the US Army.

b. These procedures pertain to hand grenades, rifle grenades, and cartridge grenades, of the types designed to inflict personnel casualties or materiel damage against the enemy, or for the employment of nonlethal chemical agents for riot control purposes, and includes practice or training grenades used to represent the operational types. Categories of grenades included are high explosive (HE), high

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explosive antitank (HEAT), fragmentation, offensive, white phosphorous, incendiary, riot control, practice, and inert.

c. Specifically excluded from these procedures are grenades designed primarily for use as signals or for screening effects (see TOP 4-3-092, Signals, Hand or Weapon Launched, Smoke/Pyrotechnic).

d. Grenades are usually furnished with fuzes installed. When fuzes are supplied for service test as a separate item, they should be installed in the appropriate type grenade and tested under the procedures contained in this document.

e. These procedures do not include determining the lethality or terminal effectiveness of the grenade, since that determination is normally made from engineering test data or lethality tests conducted by other agencies (see MTPs 3-2-608, Terminal Effectiveness of Anti-personnel Weapon System, and 8-2-093, Grenades, Hand, Riot Control).

f. The general concept of the test will be to determine the suitability of the test grenade when used by troops representative of those who will use it in the field. Test exercises should be conducted under simulated tactical conditions or conditions similar to those expected in the areas of intended operational use, and should be conducted during both daylight and darkness.

g. During all phases of testing, the test soldiers should be equipped with field uniforms, weapons, and equipment appropriate for the prevailing weather and the activities in which they are engaged. Test soldiers should be informed of the overall test objectives and the specific objectives of each test phase they will participate in.

h. During all test phases, photographic coverage to include motion pictures should be used when appropriate to supplement data obtained.

i. If the test grenade is intended to replace a standard grenade type, the standard grenade should be used as the control item.

2. Background.

a. A grenade is a small missile filled with high explosive or chemical and intended for projection against enemy personnel or materiel at relatively short ranges. Grenades are classified by method of projection as hand grenades, rifle grenades, and cartridge grenades. The hand grenade is thrown by hand in a prescribed manner; the rifle grenade is projected by a special grenade cartridge from a rifle equipped with a grenade launcher; and the cartridge grenade, a type of fixed ammunition, is fired from a weapon as a round of ammunition. Some

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hand grenades may also be projected from a rifle in a manner similar to a rifle grenade, by using a grenade projection adapter.

b. Hand grenades are designed to be thrown by the individual soldier against targets at relatively short ranges. Rifle grenades are designed to be projected from the service rifle and do not lend themselves to throwing. Rifle grenades are capable of covering the dead space to the front of defensive positions; they can fill the gap existing in high explosive firepower between the maximum throwing distance of hand grenades and the minimum safe supporting ranges of mortar and artillery fires. Weapons such as the 40mm grenade launchers M79 and M203, which fire a fixed-ammunition type cartridge grenade, have taken over many of the combat roles previously assigned to rifle grenades.

c. Riot control grenades are designed to aid in quelling civil disturbances, prisoner of war riots, or similar disorders which require the use of nonlethal agents to assist in restoring order. These grenades are also effective in clearing buildings or tunnel systems in which noncombatants may be mixed with enemy personnel, or on operations where the taking of prisoners is the primary mission.

d. Grenade fuzes may be categorized as either detonating or igniting, according to the action required to set off the filler in the grenade. Detonators are used with high explosive fillers in grenade types such as fragmentation, offensive and white phosphorous and in some riot control grenades. The detonator sets off the main charge (filler) of the grenade or, in some cases, the detonator sets off a burster charge which in turn ruptures the grenade body and disperses the filler. The igniters are used with grenades that have a burning chemical type filler such as the thermate incendiary grenades and some riot control grenades. The igniters ignite the filler, or a pyrotechnic starter, with a violent burning action and cause the filler to be expelled from the grenade body.

e. Detonating fuzes may be further categorized as either time delay or impact detonating. In time delay fuzes, the delay element is a powder train which is initiated by a primer, burns for the prescribed delay time, and thereupon initiates the detonator or igniter. The impact detonating fuze functions either upon impact or upon the lapse of a prescribed time (usually a few seconds) after the striker ignites the primer. The fuze also has an arming delay time which gives the soldier a margin of safety when he throws the grenade. The grenade is not armed until the arming delay time is expended; therefore, if a hand grenade is accidentally dropped after the safety pin has been removed, a soldier still has time to pick the grenade up and throw it to a safe area.

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3. Equipment and Facilities.

a. Equipment.

- (1) Test items.
- (2) Control items, if provided.
- (3) Weapons appropriate for test and control items.
- (4) Safety and first aid equipment.
- (5) Photographic equipment, still and motion.
- (6) Communications equipment.
- (7) Linear and weight measurement tools.
- (8) Meteorological equipment.
- (9) Tactical vehicles, ground and air.
- (10) Stopwatches.
- (11) Target materials, such as silhouette targets, tank hulls, old vehicle bodies, window and doorway mock-ups, bunkers, or other suitable items.
- (12) Parachutes and related equipment.
- (13) Administrative materials (data forms, rating questionnaires, pencils, marking pens).

b. Facilities.

- (1) Firing ranges and hand grenade ranges, as applicable to the test item.
- (2) Field training areas.
- (3) Instrumented test facilities, if available.
- (4) Classrooms, storage area, and office space.

SECTION II TEST PROCEDURES

4. Supporting Tests.

a. The procedures outlined in this TOP provide general guidance for the conduct of expanded service tests. Detailed specific procedures are dependent on the characteristics of the item being tested and the stated criteria in applicable requirements documents.

b. In preparing for the test, the test officer should conduct the necessary administrative, personnel, and supply actions outlined in his test officer's manual or in the organization's standing operating procedures (SOP). Sufficient pretest training must be accomplished to ensure test soldiers are equally familiar with the test and control items. The performance of the test item must not be degraded because it is new or the test troops were unfamiliar with it.

c. During each subtest, sufficient data should be collected to support valid conclusions. This goal may be constrained by limitations on the number of test items, the time available for testing, the manpower and funds available, and the support and control equipment available. When planning the test, the test officer should consult with methodology personnel (e.g., statistical analysts, experimental psychologists, human factors analysts), to select the best technique for collecting meaningful and sufficient data to permit a statistically valid evaluation of the test item. Methodology personnel can advise and assist the test officer in determining the appropriate experimental design to include the techniques for random sampling, the sample size required to evaluate the true performance, how to estimate average performance (or variability of performance) from a sample, how to compare materials or products with respect to average performance (or variability of performance), the number of test soldiers needed, and the number of repetitions required for a specific exercise. Additional statistical guidance may be found in TOP 3-1-002, Confidence Intervals and Sample Size, and in National Bureau of Standards Handbook 91, Experimental Statistics.

d. Common Service TOP's, the test defined in Section III, and other published documents to be considered in formulating an expanded service test plan are listed below. Additional reference material is at the appendix.

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<u>TEST SUBJECT TITLE</u>	<u>PUBLICATION NO.</u>
(1) Preoperational Inspection and Physical Characteristics (refer to para 5)	4-3-500
(2) Safety (refer to para 6)	3-3-517 and 4-3-514
(3) Personnel Training (refer to para 7)	3-3-501 and 4-3-501
(4) Functional Suitability of Hand Grenades (refer to para 8)	
(5) Functional Suitability of Weapon Launched Grenades (refer to para 9)	3-3-032
(6) Handling and Transportation	4-3-503
(7) Field Storage	4-3-520
(8) Maintenance	4-3-513 and TECR 750-15
(9) Adverse Conditions	3-3-524
(10) Security from Detection	1-3-515
(11) Airdrop Operations	7-3-511 and 7-3-512
(12) Human Factors Engineering	4-3-515
(13) Value Analysis	TECR 700-1

SECTION III
SUPPLEMENTARY INSTRUCTIONS

5. Preoperational Inspection and Physical Characteristics.

a. Objectives. To verify the completeness of the test item, to compare the physical characteristics of the test item with criteria stated in requirements documents, and to determine if the test item is in serviceable condition for testing.

b. Method.

- (1) Upon receipt, all test items should be carefully inspected

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in their shipping or packaging containers for completeness, damage, and general condition. Any evidence of damage or deterioration to the packing or containers should be recorded and photographed. The identification markings, to include nomenclature, lot numbers, name of manufacturer, and date of manufacture should also be recorded.

(2) The overpacks should be uncrated and the test item removed from the individual containers. Random samples of test items (sample size to be determined based on the confidence level required) should be selected and visually inspected for rust or corrosion; for evidence of moisture; and for bent, dented, burred or otherwise damaged items. All evidence of damage or defects should be recorded and photographed.

(3) The physical characteristics of the samples of test items should be recorded. Some examples of characteristics that might be applicable are dimensions, weight (of both individual and packaged rounds), type of material, color, and texture.

(4) Additional guidance for applicable procedures may be found in MTP/TOP 4-3-500, Preoperational Inspection and Physical Characteristics.

c. Data Required.

(1) The description of any damage or deterioration to packaging or containers.

(2) The description of any damage or deterioration to the test item.

(3) The description of the physical characteristics of the test item.

d. Analytical Plan.

(1) The physical characteristics of the test item should be compared with those of the control item or those specified in requirements documents to determine if applicable criteria are met.

(2) A subjective analysis should be made of the test data pertaining to completeness and serviceability to determine if the test item is in serviceable condition for testing.

6. Safety.

a. Objective. To determine if the test item is safe for its intended use.

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b. Method.

(1) To be safe for troop use, the test item must be safe when in field storage, when transported, and when handled and fired or detonated according to applicable regulations and procedures.

(2) Safety determination is a continuing process throughout the entire service test, and to the extent practicable should be conducted concurrently or in conjunction with other testing.

(3) Testing will not begin until the Safety Release is received. The Safety Release will be reviewed to determine if it places undue restrictions on tactical use of the test item. Prior to committing test items to field exposure, airdrop operations, detonation, or firing performance, the test item will be examined for conformity to Safety Release requirements and the presence of other hazardous conditions. Particular emphasis will be placed on verification of safety limitations cited in the Safety Release and on the compilation of safety data pertinent to the Safety Confirmation required by TECOM Reg 385-6.

(4) During the expanded service test, the test officer must constantly consider the hazards that may be encountered not only during "normal" operations but also under the worst conditions of training and combat. The test officer should not intentionally perform tests that create unsafe conditions, but he must ensure that all phases of safety have been considered. During testing, if any conditions not covered in the approved plan of test appear to need consideration, the applicable tests should be recommended for inclusion.

(5) Safe test procedures must be followed throughout all phases of testing. Test soldiers must continuously observe and inspect for indications of safety hazards, such as:

- (a) Moisture in sealed containers.
- (b) Illegible or improper markings.
- (c) Faultily constructed, inadequate, or damaged containers.
- (d) Rust deterioration, or corrosion.
- (e) Leakage of high explosive or chemical filler.

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(6) All instances of safety hazards should be recorded at the time they are observed or noticed. Unsafe items or unsafe procedures are classified as deficiencies or shortcomings in accordance with TOP 1-1-012. In this area it should be remembered that safety is relative, and judgment must be carefully exercised. In the event a suspected safety hazard or potential safety hazard develops, the problem must be resolved on the side of safety before the test is permitted to continue.

(7) During live firing or detonating exercises, consideration should be given to the wearing of ear and eye protection equipment by all participants and by observers who are in the immediate vicinity.

(8) Additional guidance for safety evaluation procedures may be found in MTP 3-3-517, Infantry Weapons and Ammunition Safety, and in MTP 4-3-514, Safety Hazards.

c. Data Required.

(1) The results of studying the Safety Release and a description of any limitations which may place undue restrictions on the tactical use of the test item.

(2) A comparison of the safety features of the test item with those stated in the applicable criteria.

(3) Any safety hazards reported or observed during conduct of the test.

(4) Any additional data which may have a bearing on the Safety Confirmation.

d. Analytical Plan. The test data should be analyzed subjectively to determine if safety criteria have been met. In compliance with the requirement of TECOM Reg 385-6, the report of test must include a statement as to whether or not the test item is safe for use. If it is concluded the test item is not safe for use, the specific unacceptable safety hazard will be fully described in detail.

7. Personnel Training.

a. Objectives:

(1) To assess the adequacy of the proposed program of instruction and of the training package.

(2) To train the test soldiers to use the test item and control item with equal proficiency.

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b. Method.

(1) The test soldiers will be selected on the basis of being representative of the intended users of the test item. Some should be left-handed, some should wear glasses, and some should represent the extremes of size. The name, rank, MOS, training time in MOS, and experience in MOS for each test soldier should be recorded.

(2) Test personnel should be familiar with the required technical and operational characteristics of the test item as stated in applicable requirements documents, and should review all instructional material issued with the test item by the manufacturer, contractor, or government. Test personnel should also be familiar with the technical and operational characteristics of the weapons that will be used to fire or project the test item. Each test soldier should understand the purpose and the objectives of the tests he will participate in. Additional training guidance is contained in MTP 3-3-501 and MTP 4-3-501, both titled Personnel Training.

(3) When a training package accompanies the test item, the instructional or training material furnished will be evaluated to determine its accuracy, clarity, completeness, and general adequacy.

(4) A course of instruction will be conducted for the test soldiers, using the training literature provided with the test item as a basis. As the training progresses, changes and refinements in the lesson plans and in the program of instruction (POI) may be made at the discretion of the test officer. At the completion of training, the suitability of the POI should be evaluated for inclusion in recommended courses of training.

(5) Instruction on the control item should be presented to the test soldiers, using the POI and subject schedules prescribed by the applicable service school.

(6) Subsequent to the completion of training, the test soldiers should complete qualification courses appropriate for the test item and the control item. Courses should be completed for both the test and control item to obtain comparative data and ensure the test soldiers are equally familiar with the test and control items.

c. Data Required.

(1) A record of the name, rank, MOS, training time in MOS, and experience in MOS, for each test soldier, at the time of his selection to participate in the test.

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(2) A record of pretest training conducted for test personnel, including subjects taught and number of hours spent on each subject.

(3) A statement concerning the proficiency of test soldiers upon completion of the pretest training, for both the test item and control item.

(4) A statement concerning the adequacy of the training package furnished with the test item.

(5) A record of individual scores attained by test soldiers on the qualification courses for both the test item and control item.

(6) A description of changes made to the initial POI, and the reasons for making the changes.

d. Analytical Plan. The test data should be analyzed subjectively to determine if training criteria have been met.

8. Functional Suitability of Hand Grenades.

a. Objectives.

(1) To determine the range and accuracy of the test item when hand thrown.

(2) To determine the reliability of the test item functioning.

(3) To determine the ease with which the test item may be handled and thrown.

b. Method.

(1) Functional suitability testing will be conducted under the conditions prescribed in test criteria and other applicable instructions, as based upon the requirements documents and test directives. Unless other requirements are specified by those sources (i.e., testing the item in the "as received" condition, after long periods of storage, etc.), the test items undergoing functional suitability testing will have previously been subjected to the procedures for handling and transportation, field storage, and airdrop operations.

(2) This subtest applies to all test items designed to be hand-thrown to the target. Test soldiers will throw the test and control items from a variety of tactical throwing stations, and from all appropriate positions (standing, kneeling, prone) against both point and area targets at various distances.

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(3) Hand grenade courses are described in FM 23-30, Grenades and Pyrotechnics Signals. If such courses are available, they should be used for this test. If such facilities are not available, a hand grenade course appropriate for the test item should be established. The design and physical layout of hand grenade courses should allow the test soldiers to engage targets in realistic environments under tactical conditions, but with maximum emphasis on safety. The test site should be of sufficient area to ensure the effects of any chemical agents used in the test do not interfere with unrelated activities outside the test area.

(4) Two main elements of a hand grenade course are a throwing station and a target/impact area. A protective barrier of some sort should be located just forward of the throwing station, to protect the thrower against fragments, blast, or ricochets of ammunition from the target/impact area. The protective barrier may be a wall, revetment, mound of dirt, log, or other similar material, or the protection may be achieved by having the throwing station located in a ditch, trench, or foxhole. Various types of throwing stations and protective barriers should be used during the test.

(5) Targets will be designed to represent realistically targets that might be encountered in tactical operations. Foxholes, trenches, bunkers, vehicles, weapon emplacements, window openings, doorways, or tunnel entrances are typical hand grenade targets. Enemy personnel may be represented by silhouette targets tactically placed singly or grouped in open terrain or in uncovered emplacements. The distances from throwing positions to targets should vary from the prescribed minimum safe range to distances beyond the maximum range the test item can normally be thrown. The requirements documents should be carefully reviewed for specific ranges, targets, and accuracy characteristics applicable to the test item.

(6) The test soldiers should be allowed some leeway in throwing techniques and throwing positions. Since few men throw in the same manner, it is difficult to establish firm rules or techniques. In actual operations, the soldier's throwing position might be dictated by the amount of available cover, the range to the target, and the type and location of the target. For the conduct of this test, however, the test soldiers should be required to use at least the standing, kneeling, and prone throwing positions. The instructions contained in FM 23-30, Grenades and Pyrotechnic Signals, may be used as guidance for employing these throwing positions. During all grenade throwing exercises, the test supervisory personnel and test soldiers should note the ease with which the test item can be handled and thrown. This should include the manner of holding the grenade in the throwing hand, removing the safety clip, pulling the safety pin or other safety devices, and maintaining pressure on the safety lever or arming sleeve until the grenade is thrown. The size, shape, and weight of the test item

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should also be considered. Any difficulties experienced by left-handed test soldiers in handling and throwing the test item should be a matter of special note.

(7) For evaluating the accuracy of hand-thrown grenades, a target hit is defined as a direct hit on a point target such as a vehicle, weapon emplacement, foxhole, window opening, doorway, bunker aperture, or tunnel entrance; or an impact within a specified radius (determined by the test officer to be of appropriate size for comparing the test and control items) of an area target, such as silhouette targets which represent troops in the open or personnel in uncovered positions.

(8) Maximum throwing range may be determined by gradually increasing the range to the targets until the throwing range of all test soldiers is exceeded.

(9) Each grenade thrown should be carefully observed and timed. The time from the moment the grenade leaves the thrower's hand until the grenade detonates or ignites should be measured. The functioning of the grenade should be observed to determine whether any duds or other malfunctions occur. Whether the grenade detonates (or ignites) prior to impact, upon impact, or subsequent to impact should be noted. For burning-type grenades the following should be noted and recorded:

(a) The burning time of the filler.

(b) Any periods of interrupted agent emission.

(c) The occurrence of any flaming or exploding during the burning period.

(10) To evaluate the arming delay feature of impact detonating fuzes, a series of grenades equipped with these fuzes should be thrown or dropped to impact on a firm surface. The distance or height of the throw or drop should be such as to cause some of the impacts to occur sooner than the specified minimum arming time, and some impacts later than the specified arming time. The time from the moment the grenade leaves the thrower's hand until detonation should be measured. If the grenade does not detonate prior to or upon impact, the time from initial impact until detonation should also be measured. If test data on arming delay time is available from the results of engineering and laboratory tests, the testing need not be duplicated during the service test.

(11) The grenades equipped with impact detonating fuzes should be impacted against a variety of target surfaces, such as metal (e.g., tank hulls or vehicle bodies), wood, hard ground, grassy sod, sand,

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mud, water, window glass, and the branches and foliage of trees.

(12) Grenade throwing exercises should be conducted during relatively stable weather conditions, since rapid changes in wind speed or direction may cause inconsistencies in the throwing results. A record of the general weather conditions (e.g., cloudy, sunny, windy), wind speed and direction relative to direction of throwing grenades, temperature, and precipitation should be made each hour during the grenade throwing exercises, or more often if significant changes occur.

c. Data Required. For each grenade thrown or dropped, the following data should be recorded:

- (1) Date and time of exercise.
- (2) Weather data.
- (3) Thrower's (or dropper's) name.
- (4) Test item nomenclature and lot number.
- (5) A description of the throwing (or dropping) station.
- (6) A description of the target/impact area and type of impact surface.
- (7) A description of the throwing position used (standing, kneeling, prone).
- (8) The distance the grenade is thrown or dropped.
- (9) Whether or not a target hit is achieved.
- (10) The time elapsed from the moment the grenade leaves the thrower's hand until detonation or ignition occurs.
- (11) Whether the grenade detonated prior to impact, upon initial impact, or subsequent to initial impact.
- (12) If the grenade does not denotate prior to or upon impact, record the time from initial impact until detonation.
- (13) The burning time, any periods of interrupted agent emission, any occurrence of flaming or exploding, any dud, and any other malfunction.
- (14) A description of any difficulty or discomfort experienced during handling and throwing the test item.

d. Analytical Plan.

(1) The data pertaining to detonation of test item should be summarized to determine the total number of grenades thrown, and the number of malfunctions or duds. The ratio of successful detonations to total grenades thrown may be used to express reliability of the test item.

(2) An appropriate statistical analysis of the test data should be made to determine if there are any significant differences between test and control items, or between test item and stated criteria, in regard to range and accuracy when hand-thrown, in the time from thrown until functioning occurs, or in the burning time.

(3) The observations and comments regarding the ease with which the test item may be handled and thrown should be analyzed subjectively to determine whether the test item is suitable in this respect.

9. Functional Suitability of Weapon Launched Grenades.

a. Objectives.

(1) To determine the soldier/launcher/ammunition accuracy of the test item.

(2) To determine the compatibility of the test item with the launching system.

(3) To determine the reliability of test item detonating or igniting.

b. Method.

(1) Functional suitability testing should be conducted under the conditions prescribed in test criteria and other applicable instructions, as based upon the requirements documents and test directives. Unless other requirements are specified by those sources (e.g., testing the item in "as received" condition, after long periods of storage, etc.), the test item undergoing functional suitability testing should have previously been subjected to the procedures for battlefield handling and transportation, field storage, and airdrop operations.

(2) This subtest applies to all test items designed to be projected to the target by means other than by hand throwing. This includes fixed ammunition-type cartridge grenades fired from grenade launchers, rifle grenades, and hand grenade that are projected from rifles by means of grenade projection adapters.

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(3) Prior to conducting the test firing exercises, the test and control launchers should be zeroed and boresighted as applicable in accordance with the procedures prescribed in the appropriate field manual or test item publication. The zero/boresight of each man/system should be recorded, and thereafter any sight adjustments should be made by setting the sight scale, or other device, at the appropriate graduation for each range. Any deviation from the appropriate graduation setting, required to hit a target, should be recorded.

(4) Grenade firing courses are described in FM 23-30, Grenades and Pyrotechnic Signals, and in FM 23-31, 40mm Grenade Launchers, M203 and M-79. If such courses are available they should be used for firing the test item. If such facilities are not available, a firing course appropriate for the test item should be established. Ranges for grenade firing exercises should vary from the prescribed minimum safe range to ranges beyond the stated maximum effective range of the launcher being fired. (Sight configurations and ammunition types may also influence the minimum and maximum ranges.) Requirements documents should be carefully reviewed for specific ranges, targets, and accuracy characteristics applicable to the test item. Well defined and easily identifiable targets should be set up at known distances from the firing points, so the firing results will not be affected by the firer's range estimations.

(5) The firing course should include both point targets and area targets in a tactical environment. Both the test and control items should be fired from a variety of tactical firing points, representative of those expected to be used in riot control or tactical operations, as appropriate, at stationary and moving targets at varying ranges. Target arrays should be set up as individual and multiple targets in tactical dispositions and should contain both personnel and materiel-type targets.

(6) For evaluating the accuracy of grenade firings, a target hit is defined as a direct hit on a point target, such as vehicle, window, doorway, or bunker aperture; or an impact within a specified radius (determined by the test officer to be of appropriate size for comparing the test and control items) of an area target, such as silhouette targets which represent troops in the open or personnel in uncovered positions.

(7) The firing exercises should include the use of all sighting devices and techniques available with both the test and control items. The firing positions used (standing, kneeling, sitting, prone) should be the most stable ones appropriate to the weapon being fired. A sufficient number of grenades should be fired, for each type grenade, firing mode, firing position, and target range to obtain statistically valid data.

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(8) All firing exercises should be closely observed for any indications of incompatibility between the test grenade and the launching system. Note should be made of any difficulties in loading or firing the grenades, any ballistic mismatch between the test grenade and the sight calibration of the launcher, and any detrimental effects on the operating characteristics of the launching system caused by firing the test grenades.

(9) Each grenade fired should be carefully observed and timed. The time from launching or firing until the grenade functions should be measured. The functioning of the grenade should be observed to determine whether any duds or other malfunctions occur. For burning grenades, the following should be noted and recorded:

- (a) The burning time of the agent.
- (b) Any periods of interrupted agent emission.
- (c) The occurrence of any flaming or exploding during the burning period.

(10) For grenades with impact type fuzes, it should be noted whether the grenade functions upon impact. In order to evaluate adequately the functioning of grenades with impact type fuzes, consideration should be given to impacting the test item against a variety of target surfaces, such as metal (e.g., tank hulls or vehicle bodies), wood, hard ground, grassy sod, sand, mud, water, window glass, and the branches and foliage of trees.

(11) Firing exercises should be conducted during relatively stable weather conditions, since rapid changes in temperature, wind speed, or wind direction may cause inconsistencies in the firing results. The temperature and wind vector relative to the line of fire should be measured at the firing range and recorded during the firing of each target. A record of the general weather conditions (e.g., cloudy, sunny), relative humidity, and precipitation should be made each hour during the firing, or more often if significant changes occur.

c. Data Required. For each target engaged the following should be recorded:

- (1) Date and time of firing.
- (2) Firer's name.
- (3) Weather data.
- (4) A description of the launching system.

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- (5) A description of target.
- (6) The target range (distance).
- (7) A description of the tactical firing point.
- (8) Firer's position (standing, kneeling, sitting, prone).
- (9) Test item nomenclature and lot number.
- (10) Sight setting on launching system.
- (11) Number of grenades fired.
- (12) Number of target hits.
- (13) The burning time, any periods of interrupted agent emission, any occurrence of flaming or exploding, any dud, and any other malfunction.
- (14) A description of any difficulties encountered in loading, sighting, or firing the grenades.
- (15) A description of any occurrence that indicated incompatibility between the test item and the launching system.

d. Analytical Plan.

- (1) Accuracy, compatibility, and functional reliability can be determined only after a valid analysis of many observations has been made, the results studied, and then evaluated by experienced personnel who are thoroughly familiar with service test procedures.
- (2) Weather data will be analyzed in relation to functional test results, to isolate the effects of weather from the total performance data.
- (3) The ratio of the number of target hits to the total number of grenades fired is a measure of accuracy, expressed as a hit percentage. This measure is an estimate of the total performance of the soldier/weapon system, and should be computed for each type grenade.
- (4) Test results pertaining to compatibility of the test item with the launching system should be presented in narrative form supplemented with tables, charts, photographs, and motion pictures as required. These data should be analyzed subjectively to determine if applicable criteria have been met.
- (5) Test results pertaining to the reliability of test item fuze functioning may be presented in narrative form, which would state

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so many grenades were fired, so many were observed to function normally, and so many were observed to malfunction. Malfunctions data should be computed for each target range and type of target surface. Malfunctions data may also be expressed in other terms such as percentage of grenades fired, or number of rounds between malfunctions, in order to conform with specifications or terminology stated in requirements documents.

(6) Appropriate statistical analyses should be performed to determine if there are significant differences in the measures of accuracy and reliability between the test and control item, or between the test item and established criteria. Comparison results should indicate whether the test item is worse than, equal to, or better than the control item or the established criteria.

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APPENDIX
REFERENCES

1. AR 70-10, Test and Evaluation During Research and Development.
2. FM 23-30, Grenades and Pyrotechnic Signals.
3. FM 23-31, 40-mm Grenade Launchers, M203 and M-79.
4. National Bureau of Standards Handbook 91, Experimental Statistics.
5. TECR 70-23, Equipment Performance Reports.
6. TECR 70-24, Documenting Test Plans and Reports.
7. TECR 310-6, TECOM Test Operations Procedures.
8. TECR 385-6, Verification of Safety of Materiel During Testing.
9. TECR 750-15, Maintenance Evaluation During Testing.
10. TOP 1-1-012, Classification of Deficiencies and Shortcomings.
11. TOP 1-1-046, Field Combat Test Exercises.
12. TOP 3-1-002, Confidence Intervals and Sample Size.
13. TOP 3-2-608, Terminal Effectiveness of Antipersonnel Weapon Systems.
14. TOP 4-3-092, Signals, Hand or Weapon Launched, Smoke/Pyrotechnic.
15. TOP 8-2-093, Grenades, Hand, Riot Control.

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